# Eighth Report to the Governments of Canada and The United States

July 2000

By The

## Souris River Bilateral Water Quality Monitoring Group

1998

# EIGHTH REPORT TO THE GOVERNMENTS OF THE UNITED STATES AND CANADA

**by the**

## SOURIS RIVER BILATERAL WATER QUALITY MONITORING GROUP

**1998**

**July 2000**

# SOURIS RIVER BILATERAL WATER QUALITY MONITORING GROUP


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**July 17, 2000**

**Department of State**
**Washington, D.C.**
**United States of America**

**Department of External Affairs**
**Ottawa, Ontario**
**Canada**

**The October 26, 1989, Agreement between the Government of the United States of America and the Government of Canada for Water Supply and Flood Control in the Souris River Basin includes a provision for the establishment of the Bilateral Water Quality Monitoring Group. The Agreement states that the Monitoring Group will prepare an annual report to be submitted to governments.**

**This is the eighth annual report prepared by the Monitoring Group. It covers the 1998 calendar year. We believe the Bilateral Monitoring Group has made significant progress in its mandate as well as contributing to the wise management of the basin's water resources.**

**Respectfully submitted,**

**D.R. Fewless**
**Chairman**
**United States Section**

**Wm. Gummer**
**Chairman**
**Canadian Section**

# Eighth Report To The Governments of Canada and the United States by the Souris River Bilateral Water Quality Monitoring Group 1998

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# EIGHTH REPORT TO THE GOVERNMENTS OF THE UNITED STATES AND CANADA by the SOURIS RIVER BILATERAL WATER QUALITY MONITORING GROUP 1998

## 1.0 HIGHLIGHTS

**The Souris River Bilateral Water Quality Monitoring Group was established on October 26, 1989, in accordance with the Canada-United States Agreement for Water Supply and Flood Control in the Souris River Basin.**

**This report is the eighth report to governments summarizing the issues and deliberations to date. The highlights are as follows:**

1. **The Bilateral Group held meetings on June 18, 1998, in Winnipeg, and on December 8, 1998, in Minot.**

2. **The Monitoring Task Force held a conference call November 17, 1998. Topics discussed were Trend Analysis, Sediment Toxicity Methods, and Monitoring.**

3. **A method for trend analysis was selected, and a summary draft report was reviewed.**

4. **The monitoring plan was changed from nine site visits each year to eight site visits. This was done to accommodate recommendations for Trend Analysis by USGS.**

5. **Bioassays and algal assays were conducted on water samples from the two border crossings.**

6. **Monitoring of water quality for transboundary objectives continued in accordance with the monitoring plan.**

7. **Below average precipitation in the Basin resulted in well below normal runoff throughout the Basin.**

# 2.0 INTRODUCTION

**The Souris River rises in southern Saskatchewan, flows in a southeasterly direction across the international boundary into North Dakota, then veers north and recrosses the boundary into Manitoba (Figure 3). Water management of the Souris River is a challenge because of the alternating periods of flood and drought that typify the water regime of the basin. Regulation of the erratic water supply is facilitated by the recently constructed Rafferty Reservoir on the Souris River near Estevan and Alameda Reservoir on Moose Mountain Creek near Oxbow. These reservoirs store spring runoff to provide flood control and augment water supplies for irrigation, industrial, and recreational opportunities.**

**Construction on the main reservoir, Rafferty, was completed in 1991. Construction on Alameda Reservoir was complete at year-end. The project also includes Souris River channel modifications and a diversion channel connecting Boundary Reservoir to Rafferty Reservoir.**

**The reservoirs and flow regulation in the Souris River Basin have the potential to affect aquatic and terrestrial environments of the basin in the province of Saskatchewan. There are also effects downstream in the state of North Dakota and in the province of Manitoba.**

**The Rafferty-Alameda project is subject to the Boundary Waters Treaty of 1909, which sets out the basic principles governing boundary water use and management between Canada and the United States. Work related to the project in Saskatchewan and in North Dakota must conform to the terms and conditions of the Treaty.**

**The government of Canada and the government of the United States of America entered into an Agreement for Water Supply and Flood Control in the Souris River Basin on October 26, 1989. Article VI of the Agreement (Appendix A) deals specifically with water quality, including provision for the establishment of a Bilateral Water Quality Monitoring Group. The Group is composed of three members from each country and is co-chaired by a Canadian and an American member. Advisors may be identified to assist the Group. Members of the Group for 1998 are given below.**

**The Bilateral Water Quality Monitoring Group is responsible for interpreting and exchanging data, preparing an annual report for governments on Souris River water quality, as well as developing recommendations to governments on the monitoring program and establishing water quality objectives at the two boundary crossings of the Souris River. If the annual report indicates there are exceedances of objectives, the Group is responsible for determining how the objectives can be met, revised, or otherwise addressed.**

**This report of the Souris River Bilateral Water Quality Monitoring Group to the Government of Canada and the Government of the United States of America covers the calendar year 1998. The report is in fulfillment of the requirements of the Agreement.**

## Souris River Bilateral Water Quality Monitoring Group

**Members for the United States**

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**Director**
**Division of Water Quality**
**North Dakota Department of Health**
**Bismarck, North Dakota**

**Mr. G.J. Wiche**
**District Chief**
**Water Resources Division**
**United States Geological Survey**
**Bismarck, North Dakota**

**Mr. M.H. Dodson**
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**Water Management Division**
**United States Environmental Protection Agency**
**Denver, Colorado**

**Members for Canada**

**Mr. Wm. Gummer**
**Director**
**Inland Waters Directorate**
**Conservation and Protection**
**Environment Canada**
**Regina, Saskatchewan**

**Mr. Joseph Muldoon**
**Director**
**Env. Protection Branch**
**Saskatchewan Environment and Resource**
**Regina, Saskatchewan**

**Mr. N.B. Brandson**
**Deputy Minister**
**Manitoba Environment**
**Winnipeg, Manitoba**

# 3.0 BASIN WATER SUPPLY

## 3.1 Hydrologic and Climatic Conditions

**Drought conditions effectively ended in the Souris River Basin in July 1993. Below to well below precipitation in the Basin resulted in well below normal runoff in most areas of the Basin. Lightest runoff occurred in the Upper Souris Basin, and minor flooding occurred between Towner, N.D. and J.Clark Salyer Refuge, and below Dam 357 into Manitoba.**

## 3.2 Reservoir Storage

**Runoff in the Upper Basin was well below normal. Combined storage in these reservoirs at the end of 1998 was 467,200 dam$^3$ (378,790 acre-feet). All inflow to Alameda Reservoir was stored in 1998. Storage was down slightly from 1997. (Figure 1B).**

**Construction of the Souris Basin Project in Saskatchewan is complete. The Tetzlaff Agreement expired in March 1998. The reservoir can now be operated at full supply level. At Rafferty Reservoir, an interim full supply level of 549.5 meters (1802.8 feet) was adopted.**

**Major storage facilities in North Dakota include Lake Darling and the J.Clark Salyer Refuge pools. (Figure 1A). The Souris River flood control project in North Dakota is considered complete.**

**At the end of 1998, storage in Lake Darling was 122,490 dam$^3$ (99,300 acre-feet), and storage in the J.Clark Salyer Refuge pools was 68,500 dam$^3$ (35,500 acre-feet).**

**The target elevation of 1597.0 ft. will be maintained at Lake Darling from April 1 through February 1, unless releases are required to meet fish and wildlife objectives either on the Upper Souris National Wildlife Refuge or at J.Clark Salyer National Wildlife Refuge. An attempt will be made to maintain a full pool, but the elevation at freeze-up will be determined by evaporation, available runoff, and releases to J.Clark Salyer.**

**Regardless of the estimated volumes of runoff, the lake will be operated to ensure that it is at or below 1596.0 ft. by February 1 of each year. Additional drawdown prior to April 1 that takes place as a result of the predicted (uncontrolled) runoff volume at the Sherwood Crossing will be based on Plate A-4 of Annex A of the 1989 International Agreement. Any releases required after April 1 shall be made after consultation with Manitoba.**

## 3.3 Apportionment Releases

**A significant water demand on the Saskatchewan portion of the basin is the water apportionment commitment at the international boundary (Figure 2).**

**The 1959 Interim Measures, administered by the International Joint Commission (IJC) on behalf of governments, stipulate that North Dakota is entitled to one-half of the natural flow of the river in any given calendar year. The IJC created the International Souris River Board of Control to ensure compliance with the Figure 1A provisions of the Interim Measures. In 1989, Canada and the United States entered into an Agreement for Water Supply and Flood Control in the Souris River Basin. Pursuant to this Agreement, certain of the Interim Measures were modified in 1992 for apportionment of the Souris River waters. Under conditions pertaining to a specified elevation on Lake Darling and flow at Sherwood Crossing, the minimum flow passed to North Dakota will be 40% of the natural flow at Sherwood Crossing.**

**Alameda Reservoir received little inflow during spring runoff, all of which was stored. Rainfall in late June and early July raised the reservoir to a peak daily elevation of 553.16 meters (1814.83 feet) on July 20. Uncontrolled flows from the Lower Souris Basin, combined with the release of 3 600 $dam^3$ (2,920 acre-feet) from Rafferty Reservoir and 480 $dam^3$ (390 acre-feet) from Boundary Reservoir, resulted in Saskatchewan being in deficit to North Dakota by 1 530 $dam^3$ (1,240 acre-feet). The state decided not to request delivery of the shortfall.**

**The flow of the Souris River at Sherwood was more than 0.113 cubic meters per second (4 cubic feet per second) except for the periods January 01 to February 07, March 08 to March 12, various times between July 31 and November 12, and December 28 to 31, 1998.**

**The interim measures for apportionment were tentatively modified again as of May 16, 1995. Under conditions pertaining to a specified elevation on Lake Darling and flow at Sherwood Crossing, for the remainder of the calendar year after June 1, the minimum annual natural flow apportionment to North Dakota shall be 50,000 $dam^3$ (40,500 acre-feet). Prior to June 1, Saskatchewan will deliver to North Dakota 50% of the first 50,000 $dam^3$ (40,500 acre-feet) that occurs during the first five months of the calendar year. However, implementation of the above measures was deferred in 1995, pending final approval by External Affairs Canada and the U.S. State Department.**

**The IJC's 1959 Interim Apportionment Measures stipulates that, during the months of June to October, North Dakota shall deliver a minimum flow requirement of 0.566 $m^3 s^{-1}$ (20 cfs) to Manitoba, which can be reduced in the event of severe drought. The total flow at the Manitoba-North Dakota boundary during this period was 99,430 $dam^3$ (80,610 acre-feet). Minimum flow conditions (0.566 $m^3 s^{-1}$ 20 cfs) were met at the Westhope Crossing for the entire period.**

# 4.0 TRANSBOUNDARY OBJECTIVES AND MONITORING

**The Agreement between Canada and the United States specifies that water quality objectives would be developed cooperatively for the Souris River at the Saskatchewan-North Dakota and the North Dakota-Manitoba boundaries.**

**The Souris River Bilateral Water Quality Monitoring Group established the Monitoring Task Force to review and compare the water quality objectives, guidelines and/or standards from the various jurisdictions involved and develop a set of transboundary objectives/guidelines for the protection of various water uses on the Souris River. The Task Force also reports exceedances of the objectives/guidelines to the Souris River Bilateral Water Quality Monitoring Group and specifies the format for reporting exceedances. In addition, the Task Force was responsible for developing and implementing a water quality monitoring program consistent with the established water quality objectives/guidelines.**

**The recommended transboundary objectives for each border crossing are described in the report entitled "Souris River Basin International Water Quality Objectives for the Saskatchewan/North Dakota and North Dakota/Manitoba Boundary Crossings." The specific process used to develop the water quality objectives is outlined in the report of the Souris River Water Quality Objectives Task Force. These recommendations were approved by the Governments of Canada and the United States in 1992. Objectives are shown in Appendix C.**

**In accordance with Article VI, the Group is mandated to review the applicability and effectiveness of the water quality objectives and recommend changes as may be necessary. Also, if the uses change in any of the jurisdictions, they will be considered in the annual evaluation of the effectiveness of the objectives and will be noted in future annual reports. There were no changes to the objectives in 1998. Article VI of the Agreement calls for a joint water quality monitoring program in the relevant portions of the Souris River Basin. The Task Force submitted a monitoring plan which was adopted in 1992 (Appendix B).**

**The monitoring plan required at the two border crossings (Figure 3) was designed to identify water quality exceedances and delineate trends. These data are to be used by the various jurisdictions to initiate corrective measures sufficient to comply with the Boundary Waters Treaty. An integral component of interpreting data at the borders is monitoring hydrologically significant reservoirs in the watershed. These include Rafferty, Alameda, and Lake Darling.**

**The chemical, physical, and biological processes occurring in reservoirs are significantly different from those occurring in rivers. This is more pronounced in reservoirs that thermally stratify and have limited capabilities to discharge from various depths. Limnological data for the reservoirs will provide essential information to the Monitoring Group and subsequently expedite recommendations for corrective measures.**

## 4.1 Trend Analysis Report

**The 1991 bilateral agreement on water quality objectives for the Souris River stipulates that "Monitoring Task Force will compile a background document synthesizing all historic water quality data for each of the Souris River Basin International Water Quality Objectives." This document will utilize agreed upon trend analysis methodology to establish the background water quality at the two transboundary locations for water objectives.**

**The Trend Analysis Report will use a parametric time series model that will detect trends in historic constituent concentration data. The trend analysis should detect complex nonmonotonic trends in concentrations in the presence of complex interannual and seasonal variability in daily discharge. The methodology used should also be compatible with changes in monitoring frequency and timing. The Draft Report will be prepared by the USGS and available for review during 1999.**

## 4.2 Monitoring Plan Changes

**The Monitoring Plan for the two boundary sites was changed from nine site visits per year to eight site visits per year. The Monitoring Plan calls for three samples from March to June, three samples from July to October, and two samples from November to February. The revised Monitoring Plan will be implemented in calendar year 1999.**

## 4.3 Sediment Toxicity Testing

**The Monitoring Task Force recommended to the Group that sediment be tested for toxicity to aquatic life. Pollutants entrained in or attached to sediment represents an unassessed component of water quality at the two boundary sites.**

**The Group recommended that Environment Canada continue to evaluate the various sediment toxicity testing protocols and, subsequently, select an appropriate method and conduct tests in 1999.**

## 4.4 Revision of Phosphorus Objectives

**The Group decided not to change the numeric objective of 0.10 mg/l for total phosphorus. Phosphorus frequently exceeds this concentration at the two boundary sites. Phosphorus is an essential element for plant growth; however, high concentrations frequently result in algal blooms and excessive plant growth.**

**Major sources of phosphorus are erosion, point source discharges, decaying aquatic plants, and release from sediment.**

## 4.5 Algal Assays

**Algal assays were conducted on water samples collected in mid summer 1997, fall 1997, and April 1998. Results were inconclusive; however, the data suggest that nitrogen was a limiting nutrient during mid summer 1997, and neither nitrogen or phosphorus appeared to limit growth during fall 1997 or April 1998.**

**The Monitoring Task Force was directed to review the algal data and consider the need for studies that would elucidate growth limiting substances. These could include micronutrient limiting factors; delineation of algae taxa; conducting algal assays on indigenous algae; or reviewing other chemical, physical, or biological factors.**

## 4.6 Bioassays

**Bioassays were conducted on water samples collected at the two boundary sites during April 1998. Fathead minnow and Ceriodaphnia dubia chronic toxicity tests were conducted. The results of the tests suggest no toxicity at either site for the two organisms tested.**

# 5.0 TRANSBOUNDARY WATER QUALITY

## 5.1 Overview of Water Quality

**When water quality objectives are not met, such conditions are referred to as "exceedences." A summary of water quality exceedences for 1998 is reported in Appendix C.**

**Below average water supply conditions prevailed in 1998. No releases from Alameda Reservoir occurred during 1998. Water quality was relatively stable compared to the previous year, but showed considerable improvement over the 1990/1991 monitoring. For the second time since reporting began, there were no exceedances of boron. There was one exceedance of TDS during 1998. A TDS concentration of 1070 was detected at the Sherwood site.**

**At the Westhope site, a maximum TDS of 1248 mg/l was recorded.**

**Sodium exceeds objectives at Westhope 75% of the time, and exceeded the objective 80% of the time at Sherwood. Chloride also exceeded the objective at Westhope 25% of the time.**

**Iron exceedances at Sherwood decreased to 86% from 100% the prior year, and iron exceedances were approximately the same as 1997 at Westhope, at 41%.**

**There was no monitoring for suspended solids during 1998.**

**There were no exceedances of pH guidelines at Sherwood in 1998. At Westhope, there were 46% exceedances (down slightly from 1997).**

**Unionized ammonia is reported as equivalents of ammonia ($NH_3$) rather than as equivalents of N. There were no exceedances of ammonia in 1998.**

**Dissolved oxygen exceedances (<5.0 mg/l) at Sherwood and Westhope were 8% and 10%, respectively, compared to 0% and 10%, respectively, in 1997.**

**There were no other exceedances at the Westhope site; however, chlordane, phenols, and PCBs occasionally exceeded the objectives at Sherwood.**

## 5.2 Changes to Pollution Sources in 1998.

**There were no changes to pollution sources in 1998. Nonpoint source pollution from agriculture remains potentially the most prevalent source of pollution in the Souris Basin. This is reflected in high total phosphorus concentrations. Major point source inputs of nitrogen and phosphorus from the Cities of Estevan and Minot have been reduced by treatment systems. Smaller municipalities continue to discharge effluent intermittently.**

**Open-pit coal mining operations remains a potential source of pollution in the Basin. A major extension of the Estevan and Prairie Coal Corporation mines was approved by Saskatchewan Environment and Resource Management in 1995.**

**The use of Rafferty Reservoir for apportionment releases instead of Boundary Reservoir has significantly reduced water quality problems, including high boron and total dissolved solids reported in previous years.**

# 6.0 OVERVIEW OF CURRENT STUDIES AND PROJECTS

**Jurisdictions in the Souris River Basin carry out water management and many water quality related studies and monitoring (Figure 3) independently of one another and of the terms of the agreement. An overview of these activities for 1996 is described below.**

**<u>Saskatchewan</u>**

**Saskatchewan Water Corporation conducted water quality monitoring at several locations, with special emphasis on monitoring the Alameda and Rafferty Reservoirs in the Saskatchewan portion of the Souris River Basin. The results of this monitoring are summarized and discussed in their annual report.**

**The Department of Saskatchewan Environment and Resource Management also sampled fish flesh for mercury from the Alameda and Rafferty Reservoirs.**

**<u>North Dakota</u>**

**The North Dakota Department of Health, Division of Water Quality, continued monitoring at three sites in the Souris River Basin. The sites are Des Lacs River at Foxholm, Souris River above Minot, and Souris River**

**near Verendrye. Sampling frequency is at 6-week intervals during open water periods and one during ice-cover.**

**The intensive water quality monitoring program the Department initiated in 1997 was completed. The assessment integrated chemical monitoring at targeted sites in the Basin with biological monitoring. Preliminary information is available, and a final report will be finished in 2000.**

**Manitoba**

**Water quality monitoring continued on the Souris River in Manitoba at one site during 1998. This site is located near Treesbank, immediately above confluence of the Souris River with the Assiniboine River and, therefore, reflects contributions from the entire Souris River Watershed. Samples continued to be analyzed for a wide range of water quality variables, including plant nutrients, bacteria, major ions, physical variables, trace elements, and agricultural pesticides. Macroinvertebrate samples were again collected in 1998, similar to 1995, 1996, and 1997 from this site.**

**United States of America**

**Monitoring by USGS at Sherwood and Westhope was carried out according to the Monitoring Task Force Plan (Appendix B). Monthly sampling for water quality objectives continued on Lake Darling and J.Clark Salyer Pool #357, as recommended by the Bilateral Monitoring Group. Sampling for other USGS programs was carried out at an additional 10 sites in the North Dakota portion of the Basin, including four sites on the mainstem of the Souris River.**

**Canada**

**The monitoring plan calls for Environment Canada to sample the Souris River at Westhope, N.D. monthly from April to November, and once in January.**

**Environment Canada conducted chronic toxicity tests on Fathead minnow and Ceriodpahnia dubia using water samples from Sherwood and Westhope Crossings. The results showed no chronic toxicity at either site.**

# 7.0 WORK PLAN SUMMARY FOR 1999

**Work plans for the Group for 1999 are given below:**

1. **Monitoring Task Force will complete a report summarizing historic water quality data and trend analysis of each of the transboundary water quality monitoring sites.**

2. **Beginning in 1999, the Trends and Potentials column of the Table in Appendix C will be completed in the annual report.**

3. **Continue evaluation of the cause(s) of eutrophication.**

4. **Macroinvertebrate biological assessment work is continuing. A North Dakota report describing the first five years of the program is expected sometime in 2000.**

5. **Manitoba will continue water quality monitoring at the Treesbank site.**

# 8.0 ADDITIONAL CONSIDERATIONS

**Water quality issues in the Souris River Basin that may require ongoing or future consideration on the part of the Souris River Bilateral Water Quality Monitoring Group include:**

1. **Monitoring Task Force recommendation that, once Rafferty and Alameda Reservoirs are full, diurnal ammonia studies would be appropriate during drawdowns, which are carried out in the stratification period.**

2. **Evaluation of impacts of new projects or developments on riparian ecosystem health, as related to instream flow needs and quality.**

# 9.0 COMMENTS OF PRIOR REPORTS

**The water quality data provided in the Sixth Report covering 1996 was erroneous. The 1994 water quality data were inadvertently included in Appendix C in the 1996 report. The overview of water quality (Section 5.1) in the Seventh Report compared 1997 to 1994 for the Sherwood site. A reexamination of the data suggests there were no significant misinterpretations in the report.**

# APPENDIX A

**Article VI of the**
**Agreement Between the United States of America**
**and the Government of Canada**
**for Water Supply and**
**Flood Control in the Souris Basin**

**Article VI of the agreement, which deals with water quality, states that:**

**1. The Parties shall ensure that all activities pursued under the terms of this agreement are consistent with applicable provisions of the Boundary Waters Treaty, particularly those of Article IV, paragraph two.**

**2. The Parties shall establish a Joint Water Quality Monitoring Program ("the Program") in the relevant portions of the Souris River basin.**

**3. The Parties shall establish, within six months of the entry into force of this agreement, a Bilateral Water Quality Monitoring Group ("the Group"). The Group shall be composed of six members, three appointed by each Party, and be co-chaired by a Canadian and a United States of America member. Each Party may also identify advisors to the Group to assist its respective members.**

**4. The initial United States of America members of the Group shall include a representative of each of the United States Environmental Protection Agency, the North Dakota Department of Health and Consolidated Laboratories, and the United States Geological Survey. A representative of the United States Fish and Wildlife Service, the United States Department of the Army, and the North Dakota State Engineer shall serve as the initial advisors to the United States of America members of the Group.**

**5. The initial Canadian members of the Group shall include a representative of each of the Government of Canada, the Government of Saskatchewan, and the Government of Manitoba.**

**6. The Group shall:**

**a. develop recommendations for the Parties on the Program and on water quality objectives;**

**b. on a regular basis, exchange data provided by the Program;**

**c. collate, interpret, and analyze the data provided by the Program;**

**d. review the Program and the water quality objectives at least every five years and recommend to the Parties, as appropriate, any modifications to improve the Program and the water quality objectives; and**

**e. prepare an annual report to be submitted to the Parties containing:**

**i. a summary of the principal activities of the Group during the year;**

**ii. a summary of the principal activities affecting water quality in the Souris River basin during the year;**

**iii. a summary of the collated, interpreted, and analyzed data provided by the Program;**

**iv. a summary of the water quality of the Souris River at the two locations at which it crosses the International Boundary between Canada and the United States.**

**viii. recommendations on new water quality objectives or on how existing water quality objectives can be met, including suggestions on water quality as it relates to water quantity during periods of low flow, in the event that the annual report indicates that the water quality objectives have not been attained as a result of activities pursued under this agreement.**

**7. The Parties shall, by April 1, 1991, establish water quality objectives for the Souris River at the Saskatchewan/North Dakota boundary and at the North Dakota/Manitoba boundary.**

**8. The Parties shall make reasonable efforts, consistent with then existing legal authorities, to implement the recommendations of the Group and, where reasonably practicable, to improve water quality in the Souris River basin.**

**9. If the annual report of the Group indicates that the water quality objectives are not being attained, the Parties shall commence consultations to determine how the water quality objectives can be met, revised or otherwise addressed. Such consultations shall include participation by interested states, provinces, and agencies.**

# APPENDIX B

## Souris River Water Quality Monitoring Plan at the Two Border Crossings and Suggested Supplementary Monitoring of Large Impoundments

## Souris River Basin Water Quality Monitoring Plan

| Parameter | Saskatchewan/ND Border | Manitoba/ND Border |
|---|---|---|
| Arsenic (total) | 1 | 2 |
| Barium (total | 1 | 2 |
| Boron (total) | 1 | 2 |
| Beryllium (total) | 1 | 2 |
| Cadmium (total) | 1 | 2 |
| Chromium (total) | 1 | 2 |
| Cobalt (total) | 1 | 2 |
| Copper (total) | 1 | 2 |
| Iron (total) | 1 | 2 |
| Lead (total) | 1 | 2 |
| Molybdenum (total) | 1 | 2 |
| Nickel (total) | 1 | 2 |
| Selenium (total) | 1 | 2 |
| Zinc (total) | 1 | 2 |
| | | |
| Ammonia (total) | +4 diurnal/year* | +4 diurnal/year* |
| *Rising hydrograph, declining hydrograph, July, October<br>Diurnal: 1 sample every 3 hours for 24-hr period (9 samples) | | |
| Nitrate/Nitrite as N | 1 | 2 |
| Nitrogen (total) | 1 | 2 |
| Phosphorus (total) | 1 | 2 |
| Chloride | 1 | 2 |
| Fluoride | 1 | 2 |
| Sodium | 1 | 2 |
| Sulfate | 1 | 2 |
| Organic Carbon (total) | 1 | 2 |
| Hardness (total) | 1 | 2 |
| Dissolved Solids (total) | 1 | 2 |
| Suspended Solids (total) | 1 | 2 |
| Phenols (total) | 1 | 2 |

| Parameter | Saskatchewan/ND Border | Manitoba/ND Border |
|---|---|---|
| Conductivity | continuous | continuous |
| pH | continuous | continuous |
| Temperature | continuous | continuous |
| Dissolved Oxygen | continuous | continuous |
| Fecal Coliforms | 1 | 2 |
| Chlorophyll a | open water | open water |
| Aluminum (total) | 4/year | 4/year |
| Aesthetics | 1 | 2 |
| | | |
| Atrazine | 3 | April, May, June, July |
| Bromoxynil | 3 | April, May, June, July |
| Carbaryl | 3 | April, May, June, July |
| Chlordane | 3 | April, May, June, July |
| DDT | 3 | April, May, June, July |
| Dieldrin | 3 | April, May, June, July |
| Dicamba | 3 | April, May, June, July |
| Diclofop-methyl | 3 | April, May, June, July |
| Heptachlor | 3 | April, May, June, July |
| MCPA | 3 | April, May, June, July |
| Parathion | 3 | April, May, June, July |
| Picloram | 3 | April, May, June, July |
| Polychlorinated biphenyls | 3 | April, May, June, July |
| Triallate | 3 | April, May, June, July |
| 2,4-D | 3 | April, May June, July |

| Parameter | Saskatchewan/ND Border | Manitoba/ND Border |
|---|---|---|
| | | |
| Bioassay (fathead minnow) (acute and chronic) | 2/year* | 2/year* |
| *During the rising hydrograph and in late summer | | |
| Fish (flesh analysis for mercury, selenium, lead, chromium, cadmium, arsenic, PCBs, and selected organics) | 1/year<br><br>Late summer or fall | 1/year<br><br>Late summer or fall |
| Sediment (deposition zone) | Once* | Once* |
| *1" deep - composite 10 samples - 1 analysis metals & organic (nonsoluble) | | |

[1] A minimum of seven samples will be taken per year. Late fall, under ice, two on rising hydrograph, peak discharge, two on declining hydrograph. At least three samples will be taken during reservoir releases. (Rising, peak, and declining hydrograph.) One regular sampling time may coincide with reservoir releases.

[2] A minimum of ten samples will be taken per year (winter, two during rising hydrograph, at peak discharge, June, July, August, September, and October and pre-ice in November).

[3] These parameters will be sampled four times per year (rising hydrograph, peak discharge, July and September).

Reservoir Monitoring

These include the large impoundments (Rafferty, Alameda, Darling, Boundary, and J. Clark Salyer) in the Souris River Basin

| Parameter (1-meter intervals) | Monthly during open water, once in late winter | Quarterly during open water, once in late winter |
|---|---|---|
| Dissolved Oxygen | X | |
| Temperature | X | |
| pH | X | |
| Secchi disk | X | |
| Conductivity | X | |
| (Outlet elevation and 1 meter below surface) | | |
| Nitrogen (total) | X | |
| Nitrate/Nitrite as N | X | |
| Ammonia (total) | X | |
| Phosphorus (total) | X | |
| Chloride | X | |
| Fluoride | X | |
| Sodium | X | |
| Sulfate | X | |
| Hardness | X | |
| Dissolved Solids (total) | X | |
| Phenols | X | |
| Metals (from Table 1) | | X |
| Mercury | | X |
| Organics | | X |
| Chlorophyll a (composite from photic zone) | X | |

# APPENDIX C

## 1998 Water Quality Data Summary and Objectives Exceedances for Saskatchewan/North Dakota and North Dakota/Manitoba Boundaries

ANNUAL WATER QUALITY OBJECTIVES SUMMARY
SOURIS RIVER - NORTH DAKOTA/SASKATCHEWAN BOUNDARY 1996
STATION 05114000 SHERWOOD USGS

| WATER QUALITY PARAMETERS | WATER QUALITY OBJECTIVE | UNITS | HISTORIC DATA* Median(max-min)#samples | ANNUAL DATA Median(max-min)#samples | %EXCEEDANCE | TRENDS | POTENTIAL ACTION |
|---|---|---|---|---|---|---|---|
| **Biological Parameters** | | | | | | | |
| Fecal Coliform | 200/100 ml | #/100 ml | 14(2500-0)219 | 54(130-16)3 | 0 | | |
| | | | | | | | |
| **Inorganic Parameters** | | | | | | | |
| Ammonia (un-ionized as NH3) | **** | mg/L | 0(0.15-0)58 | <0.002(0.002-0.001)9 | 0 | | |
| Chloride | 100 | mg/L | 55(268.4-2.3)331 | 36(100-6.6)9 | 11 | | |
| Fluoride | 1.5 | mg/L | 0.2(1.01-<0.05)298 | .15(0.20-<0.10)9 | 0 | | |
| $NO_2$ + $NO_3$(as N)dissolved | 1.0 | mg/L | 0.03(1.4-<0.001)292 | 0.19(0.35-<0.05)9 | 0 | | |
| Phosphorus(total P) | 0.10 | mg/L | 0.166(2.15-<0.005)303 | 0.24(0.33-0.10)9 | 100 | | |
| Sodium | 100 | mg/L | 146(525.21-21.5)330 | 97(250-26)9 | 33 | | |
| Sulfate | 450 | mg/L | 223(814-50)331 | 185(360-73)9 | 0 | | |
| | | | | | | | |
| Arsenic (total) | 0.05 | mg/L | 4(0.14-.002)18 | 2.2(<0.1-6)9 | 0 | | |
| Barium(total) | 1.0 | mg/L | 1(3-1)17 | <0.1(<0.1)9 | 0 | | |
| Boron(total) | 0.50 | mg/L | .34(.73-.15)13 | 0.15(0.27-0.04)9 | 0 | | |
| Beryllium(total) | 0.10 | mg/L | .01(.01-.00)16 | <0.01(<0.01-<0.01)9 | 0 | | |
| Cadmium(total) | ***27 | $\mu$g/L | 1(2-0)16 | <1(<1-<1)9 | 0 | | |
| Chromium(total) | 50 | $\mu$g/L | 1(30-0)17 | <1(2.0-<1)9 | 0 | | |
| Cobalt(total) | .05 | mg/L | 1(2-0)17 | 1(1-<1)9 | 0 | | |
| Copper(total) | ***30 | $\mu$g/L | 2(15-1)16 | 2(4.0-<1)9 | 0 | | |
| Iron(total) | 0.3 | mg/L | .48(9.9-.06)26 | 0.86(2.1-0.38)9 | 100 | | |

***based on hardness of 300 mg/L
****unionized ammonia is calculated using temperature and pH
NDA: No Data Available

ANNUAL WATER QUALITY OBJECTIVES SUMMARY
SOURIS RIVER - NORTH DAKOTA/SASKATCHEWAN BOUNDARY 1996
05114000 SHERWOOD USGS

| WATER QUALITY PARAMETER | WATER QUALITY OBJECTIVE | UNITS | HISTORIC DATA Median(max-min)#samples | ANNUAL DATA Median(max-min)#samples | %EXCEEDANCE | TRENDS | POTENTIAL ACTIONS |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Lead(total) | ***13 | µg/L | NDA | 1.0(3.0-<01)9 | 0 | | |
| Mercury | 0.5 ug/g in fish flesh | µg/g | <0.02(5-<.01)138 | NDA | NDA | | |
| Molybdenum(total) | 0.01 | mg/L | NDA | 2(4-<1)9 | 0 | | |
| Nickel(total) | ***220 | µg/L | 3.7(17-<2)124 | 3.3(4-3)9 | 0 | | |
| Selenium(total) | 0.005 | mg/L | 0.0004(.0034-<0.0001)194 | <1(<1)9 | 0 | | |
| Zinc(total) | 30 | µg/L | 2.2(49-<1)124 | <10(10-<10)9 | 0 | | |
| | | | | | | | |
| **Miscellaneous** | | | | | | | |
| | | | | | | | |
| Total Dissolved Solids | 1000 | mg/L | 770.7(2095-213)120 | 603(1280-224)9 | 22 | | |
| Total Suspended Solids | the lesser of 10 mg/L or 10% over ambient | mg/L | 14(225-<1)282 | NDA | NDA | | |
| pH (range) | 6.5-8.5 | standard units | 8.1(9.5-6.5)276 | 8.0(8.6-6.9)8 | 12 | | |
| Dissolved Oxygen (conc.) | >5.0 | mg/L | 8.15(17.8-0)282 | 11.0(13.6-5.7)8 | 0 | | |
| Aesthetics | | visual | NDA | NDA | NDA | | |
| Oil and Grease | | visual | NDA | NDA | NDA | | |
| | | | | | | | |
| | | | | | | | |

*** based on a hardness of 300 mg/L
NDA: No Data Available

ANNUAL WATER QUALITY OBJECTIVES SUMMARY
SOURIS RIVER NORTH DAKOTA/SASKATCHEWAN BOUNDARY 1996
STATION 05114000 SHERWOOD USGS

| WATER QUALITY PARAMETER | WATER QUALITY OBJECTIVE | UNITS | HISTORIC DATA Median(max-min)#samples | ANNUAL DATA Median(max-min)#samples | %EXCEEDANCE | TRENDS | POTENTIAL ACTION |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Organic Parameters** | | | | | | | |
| Atrazine | 2 | µg/L | 0.014(0.014-0.014)1 | <0.001(<0.001)2 | 0 | | |
| Bromoxynil | 5 | µg/L | <0.003(<0.003-<0.003)30 LTD | <0.035(<0.035)3 | 0 | | |
| Carbaryl | 90 | µg/L | NDA | <0.003(<0.003)2 | 0 | | |
| Chlordane | 0.0043 | µg/L | <0.003(<0.003-<0.003)13 LTD | 0.010(<0.010)2 | 0 | | |
| DDT | 0.001 | µg/L | <0.001(<0.001-<0.001)137 LTD | <0.010(<0.010)2 | 0 | | |
| Dieldrin | 0.0019 | µg/L | <0.002(<0.005-<0.002)174 LTD | <0.001(<0.001)2 | 0 | | |
| Dicamba | IN DEVELOPMENT | µg/L | <0.03(<0.05-<0.002)53 | <0.035(<0.035)3 | 0 | | |
| Diclofop-methyl | IN DEVELOPMENT | µg/L | NDA | NDA | NDA | | |
| Heptachlor | 0.0038 | µg/L | <0.001(<O.005-<0.0007)174 LTD | <0.01(<0.01-<0.01)2 | 0 | | |
| MCPA | 0.20 | µg/L | <0.2(<0.2-<0.02)176 LTD | <0.05(0.220-<0.050)3 | 33 | | |
| Parathion | 0.04 | µg/L | NDA | <0.01(<0.01-<0.01)2 | 0 | | |
| Picloram | 0.05 | µg/L | <0.2-<0.05)112 LTD | NDA | NDA | | |
| Phenols(total) | 1.0 | µg/L | 3(94-<1)151 | 1.8(3-<1)6 | 50 | | |
| Polychlorinated biphenyl (total) | 0.001 | µg/L | <0.002(<0.02-<0.002)116 LTD | <0.1(<0.1-<0.1)2 | 0 | | |
| Triallate | 0.57 | µg/L | NDA | 0.021(0.021-<0.001)2 | 0 | | |
| Trifluralin | 0.10 | µg/L | <0.01(<0.01-<0.01)3 LTD | <0.12(<0.12-<0.12)1 | 0 | | |
| 2,4-D | 4.0 | µg/L | <0.03(0.79-<0.004)117 | <0.035(<0.035-<0.035)3 | 0 | | |
| | | | | | | | |

b chlordane,total: 2 samples:<0.1
NDA: No Data Available

ANNUAL WATER QUALITY OBJECTIVES SUMMARY
SOURIS RIVER NORTH DAKOTA/MANITOBA BOUNDARY 1996
STATION OOMA05NF001 COULTER ENVIRONMENT CANADA

| WATER QUALITY PARAMETER | WATER QUALITY OBJECTIVE | UNITS | HISTORIC DATA[1] Median(max-min)#samples | ANNUAL DATA Median(max-min)#samples | %EXCEEDANCE | TRENDS | POTENTIAL ACTION |
|---|---|---|---|---|---|---|---|
| Biological Parameters | | | | | | | |
| Fecal Coliform | 200/100 ml | #/100 ml | 6(2300-<2)247 | 19(50-62)5 | 0 | | |
| | | | | | | | |
| Inorganic Parameters | | | | | | | |
| Ammonia (un-ionized as NH3) | **** | mg/L | 0(0.18-0.0)63 | 9(0.01-0)9 | 0 | | |
| Chloride | 100 | mg/L | 24(122-1.2)393 | 22.8*88.9-13.9)9 | 0 | | |
| Fluoride | 1.5 | mg/L | 0.2(0.56-<.05)336 | 0.17(0.31-0.09)9 | 0 | | |
| NO2 + NO3(as N)dissolved | 1.0 | mg/L | .09(.844-<.01)7 | 0.013(0.188-<0.21)9 | 0 | | |
| Phosphorus(total P) | 0.10 | mg/L | .424(.772-.21)8 | 0.301(0.405-0.153)9 | 100% | | |
| Sodium | 100 | mg/L | 100(408-11.5)393 | 1.2(282-37.,5)9 | 56% | | |
| Sulfate | 450 | mg/L | 179(655-23.1)389 | 198(462-75.3)9 | 17% | | |
| | | | | | | | |
| Arsenic (total)* | 0.05 | mg/L | .0038(.028-<.0005)221 | 0.004(0.005-0.0018)9 | 0 | | |
| Barium(total)* | 1.0 | mg/L | .089(.37-<.04)139 | 0.0813(0.21-0.043)9 | 0 | | |
| Boron(total)* | 0.50 | mg/L | .25(1.27-.06)216 | | NA | | |
| Beryllium(total)* | 0.10 | mg/L | NDA | <0.05(0.02-<0.05)9 | 0 | | |
| Cadmium(total)* | ***27 | $\mu$g/L | <1(5-<1)141 | <0.1(0.2-<0.1)9 | 0 | | |
| Chromium(total)* | 50 | $\mu$g/L | <15(<15-<15)4 | 0.5(1.1-<0.2)9 | 0 | | |
| Cobalt(total)* | .05 | mg/L | .0008(.006-<.0005)141 | 0.0005(0.0009-0.0003)9 | 0 | | |
| Copper(total)* | ***30 | $\mu$g/L | 2(38-<1)141 | 1.3(2.4-7.0)9 | 0 | | |
| Iron(total)* | .3 | mg/L | .035(1.12-<.007)173 | 0.434(1.14-0.044)9 | 67 | | |
| Lead(total)* | ***13 | $\mu$g/L | 1.3(6.7-<.7)141 | 0.2(0.4-10.2)9 | 0 | | |

1 Historic Data does not include 1992
***based on a hardness of 300 mg/L
****based unionized ammonia is calculated using temperature and pH
NDA: No Data Available

ANNUAL WATER QUALITY OBJECTIVES SUMMARY
SOURIS RIVER NORTH DAKOTA/MANITOBA BOUNDARY 1992
STATION OOMA05NF001 COULTER ENVIRONMENT CANADA

| WATER QUALITY PARAMETER | WATER QUALITY OBJECTIVE | UNITS | HISTORIC DATA Median(max-min)#samples | ANNUAL DATA Median(max-min)#samples | %EXCEEDANCE | TRENDS | POTENTIAL ACTION |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Mercury | 0.5 ug/g in fish flesh | ug/g | <.02(.11-.01)159 | N/A | N/A | | |
| Molybdenum(total)* | 0.01 | mg/L | NDA | 0.0010(0.0318-0.0066)9 | 0 | | |
| Nickel(total)* | ***220 | $\mu$g/L | 3.5(15-<2)139 | 1.9(3.0-1.6)9 | 0 | | |
| Selenium(total)* | 0.005 | mg/L | .0003(.002-0)213 | 0.0003(0.0005-0.0001)9 | 0 | | |
| Zinc(total) | 30 | $\mu$g/L | 3(32-.5)136 | 2.3(5.2-0.6)9 | 0 | | |
| | | | | | | | |
| Miscellaneous | | | | | | | |
| | | | | | | | |
| Total Dissolved Solids | 1000 | mg/L | 683(1588-0)117 | 634(469-264)9 | 11 | | |
| Total Suspended Solids | the lesser of 10 mg/L or 10% over ambient | mg/L | 13(227-<1)355 | 9.20(45.2-1.5)9 | 5 | | |
| pH (range) | 6.5-8.5 | standard units | 8.2(9.5-6.8)332 | 8.25(8.04-8.80)9 | 44 | | |
| Dissolved Oxygen (conc.) | >5.0 | mg/L | 8.4(21.6-0)329 | 7.9(1.8-12.0)9 | 11 | | |
| Aesthetics | | visual | NDA | None | | | |
| Oil and Grease | | visual | NDA | None | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

*** based on a hardness of 300 mg/L
NDA: No Data Available

ANNUAL WATER QUALITY OBJECTIVES SUMMARY
SOURIS RIVER NORTH DAKOTA/MANITOBA BOUNDARY 1992
STATION OOMA05NF001 COULTER ENVIRONMENT CANADA

| WATER QUALITY PARAMETER | WATER QUALITY OBJECTIVE | UNITS | HISTORIC DATA Median(max-min)#samples | ANNUAL DATA Median(max-min)#samples | %EXCEEDANCE | TRENDS | POTENTIAL ACTION |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Organic Parameters** | | | | | | | |
| Atrazine | 2 | µg/L | <.05(2.4-<.05)56 | <0.05(<0.05-<0.05)5 | 0 | | |
| Bromoxynil | 5 | µg/L | <.03(.15-<.03)38 | <0.03(<0.03-<0.03)2 | 0 | | |
| Carbaryl | 90 | µg/L | NDA | | | | |
| Chlordane | 0.0043 | µg/L | <.003(<.003-<.003)156 | <0.002(<0.002-<0.002)5 | 0 | | |
| DDT | 0.001 | µg/L | <.001(<.004-<.001)155 | <0.001(<0.001-<0.001)5 | 0 | | |
| Dieldrin | 0.0019 | µg/L | <.002(<.002-<.002)193 | <0.03(<0.03-<0.03)7 | 0 | | |
| Dicamba | IN DEVELOPMENT | µg/L | <.03(<.03-<.03)73 | <0.05(<0.05-<0.05)5 | 0 | | |
| Diclofop-methyl | IN DEVELOPMENT | µg/L | NDA | <0.05(<0.05-<0.05)5 | 0 | | |
| Heptachlor | 0.0038 | µg/L | <.001(.004-<.0007)193 | <0.001(<0.001-<0.001)5 | 0 | | |
| MCPA | 0.20 | µg/L | <.2(.7-<.009)196 | <0.03(0.04-<0.03)7 | 0 | | |
| Parathion | 0.04 | µg/L | <.088(<.088-<.088)1 | <40(<40<40)2 | 0 | | |
| Picloram | 0.05 | µg/L | <.05(.08-<.05)138 | <0.05(0.05-<0.05)2 | 0 | | |
| Phenols(total) | 1.0 | µg/L | 20(1800-<1)213 | LTD | 0 | | |
| Polychlorinated biphenyl (total) | 0.001 | µg/L | <.002(<.02-<.002)134 | <0..005(<0.05-<0.005)5 | 0 | | |
| Triallate | 0.57 | µg/L | <.01(.072-0)53 | 0.01(0.01-<0.01)5 | 0 | | |
| Trifluralin | 0.10 | µg/L | <.005(<.01-<.005)57 | 0.01(0.01-<0.01)5 | 0 | | |
| 2,4-D | 4.0 | µg/L | .0255(.322-<.004)200 | <0.03(0.12-<0.03)47 | 0 | | |
| | | | | | | | |
| | | | | | | | |

pp DDT: 6 samples: .004(.004-.004) // op DDT:6 SAMPLES: .001(.001-.001)
NDA: No Data Available